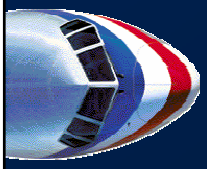

Operational Impacts of Weather at American Airlines

Tuell Green
INFORMS San Francisco 2005
November 13, 2005

Impacts of inclement weather

Inclement weather reduces the available capacity – both in airspace and at airports – for air traffic flows

Delays

Cancellations

Ground holding

Diversions

Re-routes

Air holding

Crew rule violations

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Some examples…

- **Fog in San Francisco**
  - Cuts runway capacity at SFO in half
- **Winds and rain in Chicago**
  - Precludes use of optimal runway configuration, which reduces airport capacity
- **Long band of storms across the Midwest**
  - Closes certain sectors of airspace
- **Snow storm in the Northeast**
  - Deicing at various airports severely slows down the operation
- **Thunderstorm in North Texas**
  - Shuts down DFW airport until storm passes
- **Hurricane across Florida or Caribbean**
  - Shuts down entire regions to air traffic for days

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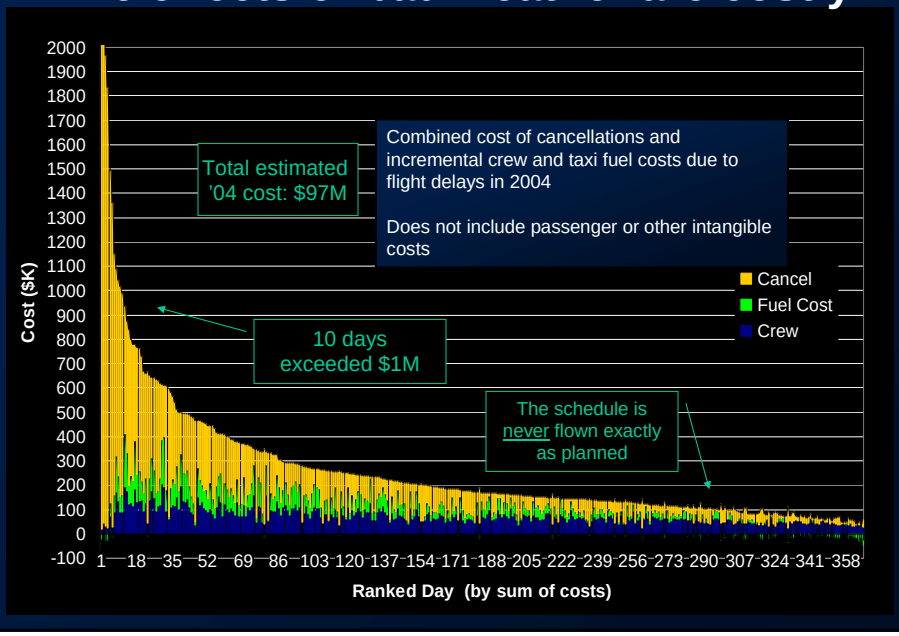
The effects of bad weather are costly...



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…and *effective* recovery is difficult

- Will the weather event materialize? — **uncertainty**
- When will it start?
- How long will it last?
- How severe will it be? — **uncertainty**
- What if it changes course, speeds up or stalls?
- How will the ATC react?
- How will other airlines react? — **uncertainty**
- What other down-line problems can we expect?

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The higher the level of uncertainty, the bigger the challenge...

- Fog is more predictable and less severe, so it's relatively easier to handle
- Snow storms are severe, but also more predictable, so pose less of a challenge
- Convective weather events (tornadoes, thunderstorms, hurricanes) are the least predictable, and therefore pose the biggest challenge

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Convective weather

Tends to appear without much warning (not predictable)

Air traffic prohibited into or through affected areas

FAA tends to initiate ground stops at the affected airport

En-route flights must be diverted or held in the air until the airport opens

Flights on the ground must be delayed or cancelled until airport opens

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Operational decisions must be made in advance of the weather event…

- **Let the flights go** → **Air holding or diversions if the airport closes**
- **Delay flights** → **Risk delaying the flights right into the storm**
- **Cancel flights** → **Risk cancelling too many, or at the wrong times**
- **Wait** → **Limited options for effective recovery**

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ATC response to inclement weather

High winds, rain, and limited visibility expected most of the day at Chicago O'Hare

Bad weather forces the airport to reduce runway capacity

Airport not able to handle the scheduled demand at reduced capacity

Without intervention, flights would queue up in the airspace around ORD waiting to land

FAA restricts the flow into ORD to match the reduced capacity

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Ground delay programs (GDPs)

- **FAA-imposed control of flight arrivals into an airport with insufficient arrival capacity, due to external constraints on the airport (weather, congestion, unscheduled demand)**
- **FAA assigns arrival slots to all inbound flights controlled under the GDP to reduce the demand on the airport**
- **FAA may modify the program several times a day due to changes in weather and airline responses**

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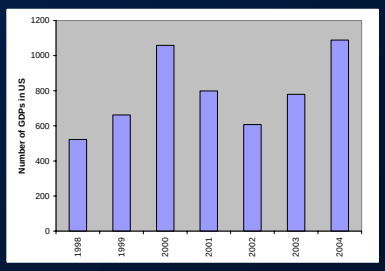
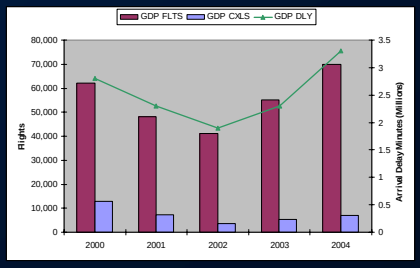
Airline response to GDPs

- **Airlines can re-assign flights to their slots according to their own economic and operational priorities**
- **Lack of time, information, and decision support reduces our ability to manage arrival slots effectively**

GDPs across the US



Impact of GDPs on AA



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Our goal is to improve decision making under uncertainty by…

- **Explicitly modeling the variability in weather patterns when evaluating alternative actions…**
- **Making probabilistic forecasts of airport capacity and its impact on AA operations**
- **Delivering decision-support tools that assess tradeoffs and make recommendations that account for the uncertainty inherent in the weather predictions**
  - Anticipate future conditions and their impact on the operation,
  - Understand the dynamic nature of those conditions, and
  - Make proactive decisions appropriate for the actual conditions

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